

Framework for a Comprehensive Monarch Recovery Plan

Monsanto Company

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Issue – Declining Eastern Monarch Butterfly Population

The Eastern monarch butterfly population has declined by ~90% over the past two decades. In August 2014, stakeholders petitioned the Fish and Wildlife Service (FWS) under provisions of the Endangered Species Act to protect the monarch butterfly. In December 2014, FWS concluded that listing under the ESA may be warranted and initiated a further review of the status of monarch butterflies.

- **Factors Contributing to Decline:** There are several contributing factors that have been identified, including logging of overwintering sites in Mexico, weather events (e.g. freezing temperatures and drought), predation, pathogens and parasites, reduced availability of host plants (milkweed species) and nectar sources across their migration range, and climate change. The combination of the above stressors has made this species ecologically vulnerable.
- **Changing Agricultural Systems:** Agricultural systems in the US have evolved over the last 20 years to become more productive and environmentally sustainable. Prior to 1995, farmers already were incorporating more sustainable practices into production, including no-till and conservation tillage systems. Reducing tillage has enormous benefits, such as less soil erosion, improved soil organic matter, less soil compaction, increased soil moisture, cleaner water, reduced energy use, more wildlife habitat, and less greenhouse emissions that contribute to climate change. The principle barrier to reducing or eliminating tillage was the challenge of controlling weeds with available soil-applied herbicides. The advent of herbicide-tolerant crops in the mid-1990s enabled farmers to control weeds better and to more widely adopt reduced tillage systems. Since the introduction of herbicide-tolerant crops, farmers have increased no-till or reduced tillage systems by about 50% in the U.S. US farmer emphasis on productivity and expansion of reduced tillage systems has led to better weed control in and around crop fields.
- **Biology:** The monarch butterfly (*Danaus plexippus plexippus*) is a milkweed butterfly (subfamily Danainae) in the family Nymphalidae. In North America, the species is divided into two primary populations, eastern and western, of which the eastern population is larger. This species conducts a multigenerational migration from the winter habitat in Mexico, through the United States and into Southern Canada annually. The bulk of the eastern population's migration occurs through the central United States. Though adult monarchs can feed on multiple nectar sources, egg laying and larval feeding only occur on various milkweeds (*Asclepius* spp.). Therefore, adequate amount of adult and larval food sources and egg-laying substrate are required throughout the migration route to support this species. In particular, the upper Midwest of the United States—where monarchs are found in the summer – has been deemed important habitat to support the later generation that will overwinter in Mexico.

- **Habitat Improvement:** Restoration and mitigation efforts can be initiated on public and private lands to increase the availability of monarch habitat and facilitate monarch population recovery during the spring-summer migration. The priority areas are in the upper Midwest region of the US, including Conservation Reserve Program (CRP) land, government-owned land, roadsides, utility rights-of-way, and on-farm conservation strips. There are existing incentive programs at the federal and state level to help farmers, U.S. state departments of transportation, and federal land managers to increase biodiversity through restoration programs. These programs need to grow and expand.
- **Role of the Ag Sector:** Successful habitat improvement must include collaboration between public sector and non-profit monarch conservation initiatives and the Ag sector. There is an opportunity to expand existing Ag Sector programs and partnerships focused on sustainability to include restoration of monarch habitat. Greater collaboration among the actors will enable greater numbers of farmers to integrate monarch habitat into existing conservation, land management and habitat expansion efforts. To make this a reality, farmers need information, guidance, and assistance to establish or improve habitat; and they need flexibility and funding to improve on-farm biodiversity while maintaining agricultural productivity.
- **Current Limitation to Broad Monarch Habitat Restoration on Public Lands:** Currently, the specifications for seeding recommendations for USDA conservation programs are written at the state level. If milkweeds (*Asclepias spp*) are not included in these state-level lists, then planting of milkweeds as part of these conservation efforts is not allowed. Milkweed is not listed as a noxious weed on any state or federal noxious weed lists. Rather, omission of milkweed from state seeding specification lists may be as an oversight, or related to concerns over the potential toxicity of milkweed to grazing animals. Federal recommendations to state entities to include milkweed in seeding mixtures will facilitate the wide scale reintroduction of milkweed habitat to support monarchs on public lands.

Proposal - Establish a Public, Private, Federal Agency Partnership to Implement a Comprehensive Recovery Management Plan

- **Framework for the Development of a Comprehensive Recovery Management Plan:** Organize and coordinate a public, private, federal agency partnership to implement a Comprehensive Monarch Recovery Plan (CMRP). The partnership would identify and implement critical elements of a multi-state plan for successful recovery and stabilization of the Eastern monarch butterfly population across a prioritized portion the spring-summer migration. The conservation strategies developed as part of the CMRP would be initiated and implemented on a voluntary basis by a multi-stakeholder consortium across multiple states in the Midwestern United States over 10-year period. Clear indications of early progress may be sufficient to avoid the need for federal listing. Conservation programs supported by the coalition would continue for as long as necessary to ensure Eastern monarch population recovery and sustainability in North America.

Using the Open Standards for the Practice of Conservation (Figure 1) developed by the Conservation Measures Partnership (<http://www.conservationmeasures.org/>), we propose a

framework for the development of a Comprehensive Monarch Recovery Plan that incorporates adaptive management and results-based management techniques. The proposed plan is based on extensive dialogue with the following experts from academia, federal agencies and the monarch butterfly conservation community and incorporates elements of existing and proposed monarch butterfly recovery programs.

Peter Raven, Missouri Botanical Garden
 Gary Nabhan, University of Arizona
 Chip Taylor, University of Kansas
 Karen Oberhauser, University of Minnesota
 Richard Hellmich, USDA-ARS
 John Pleasants, Iowa State University
 Laura Jackson, University of Northern Iowa

Additionally, we have employed design elements found within Habitat Conservation Plans (HCPs) as developed in accordance with the Endangered Species Act (ESA). Under section 10(a)(1)(B) of the ESA, HCPs provide for partnerships with non-Federal parties to conserve the ecosystems upon which listed species depend, ultimately contributing to their recovery. HCPs can apply to both listed and non-listed species, including those that are candidates or have been proposed for listing. Conserving species before they are in danger of extinction or are likely to become so, also can provide early benefits and prevent the need for listing. The HCP process allows for regional (e.g., state level) perspective on species conservation. Due to the large area of monarch migration, state-level engagement in management and recovery activities is integral to success of any recovery program.



Figure 1: Conservation Measures Partnership Open Standard for the Practice of Conservation.

Before a recovery plan such as CMRP can be initiated, several key components need to be identified, such as the goals of the program, the geographic area for recovery activities, the stakeholders involved, data gaps and research needs, funding sources, recovery plans, and measures of success. It is urgent that interested actors come together and make decisions in these important areas. Fortunately, these discussions already are underway and progress can be swift.

Quick action early in 2015 is critical to avoid further delay in habitat restoration efforts. There are legitimate concerns that investing time in building a new collaboration while necessary will divert time and focus away from planning on-the-ground actions for 2015. Fortunately, several activities/initiatives already have begun and will continue through 2015. These include GIS mapping initiatives, academic research, and limited scale habitat restoration initiatives.

- **Habitat Restoration Partnership:** The Keystone Center (TKC) in Keystone, Colorado will serve as an independent convener and facilitator for the development and implementation of the CMRP. TKC has agreed to organize a multi-stakeholder consortium of stakeholders from the Ag sector, academia, federal agencies, and non-profit conservation groups to implement a Comprehensive Monarch Recovery Plan.

Short Term Actions:

- Establish a Keystone Center Program. A primary focus of the Keystone Center effort and CMRP will be to encourage and facilitate Public Private Partnerships that will identify monarch recovery opportunities and foster relationships for capacity building, research activities, incentivizing private land owners, and habitat restoration. A core group of people representing different interest groups have begun a dialogue and have expressed interest in participating in such an initiative. Monsanto provided initial funding so that TKC could undertake a process to convene a group and begin collaborative work on a CMRP. TKC is currently in the process of reaching out to stakeholder groups in order to organize a meeting in February-March 2015. The emphasis of this meeting will be to engage and enroll a broader group of Ag sector participants in this initiative; and to begin work on other immediate activities.
- Bring Stakeholder Groups Together. Due to the large geographic area that is important for monarch success, stakeholders will be varied and comprise of representatives of the public, private, and government sectors. Examples include:
 - Agriculture Industry
 - Individual growers/land-owners
 - Public lands—federal, state and local level
 - Utilities
 - Transportation –federal and state level
 - Tribal lands
 - Academia
 - Conservation organizations

Participation in the CMRP will be voluntary, and partners will pledge to encourage monarch conservation on private and public lands in the monarch range. The strategy is based on the expectation that many small landowners will contribute willingly to conservation programs when they are able to do so voluntarily, without legal requirements or mandates. This approach has been successful with species such as the Karner Blue Butterfly and the Western Sage Grouse. The CMRP will use programs such as these as templates for designing monarch-specific programs and activities.

Medium Term Actions:

- Design Outreach, Education, and Assistance/Incentive Programs. A key to successful adoption and implementation of the CMRP will be the development of a vigorous outreach and education strategy to secure the voluntary participation of landowners. As part of a non-regulatory approach, public outreach, education and assistance/incentive programs will be designed and encouraged at the national, state and local levels. These outreach and education programs will be intended to be user-friendly and non-threatening to encourage cooperation on the CMRP. To secure voluntary participation, the CMRP will need to develop plans/programs that assure landowners and land users that monarch conservation efforts will not be disadvantageous.
- Support Funding for Conservation Measures. The strength of this multi-state and multi-stakeholder conservation plan is the commitment to grass roots conservation measures on large tracts of public and private land throughout the migratory path of the monarch butterfly. The CMRP stakeholders and other cooperators will commit to work together in a cooperative plan designed to assure the future of the monarch butterfly through their collective conservation efforts conducted while continuing their normal management and land use activities.

CMRP stakeholders will bring together a variety of types of support for monarch recovery including financial, technical, advocacy/education, and supply resources. The strength behind the coalition is the CMRP stakeholder's commitment to monarch recovery as organized through the Keystone Center.

Individual stakeholders may fund their own recovery activities, or partially fund group efforts, as determined through consensus at the organizing level.

- **Geographic Focus Areas for Habitat Restoration:** Researchers from the University of Illinois at Chicago are collaborating with the USGS Powell Center Monarch Conservation Working Group to identify lands that are available for habitat improvement or conversion outside of productive agricultural land. They are applying geospatial analysis to various datasets to develop maps that will correlate, overlay, and analyze different data layers to identify areas for habitat support that meet economic viability and impact screening. Their analysis includes: a) monarch migration and breeding areas, b) production agriculture productivity layers (USDA yield and UIC marginal land layers), and c) infrastructure layers (rail, transmission, pipeline easements). This effort will help identify and prioritize important geographies for focused restoration efforts. Additionally, this effort will identify and classify available lands and determine use patterns.

Short Term Actions:

- Make Geospatial Dataset Publicly Available. The geospatial data set is anticipated to be publically available via the Data Basin website in February 2015. These data and recommendations from the working group are anticipated to be made in March 2015.
- Identify Geographic Focus Areas for Habitat Improvement. Initial analysis suggests that conversion of highly productive croplands for habitat restoration can be avoided in many states as multiple other land use areas are available for restoration to a varying degree across key states. Across a six-state area that encompasses key monarch migration habitat (i.e., Minnesota, Wisconsin, Michigan, Iowa, Kansas, and Missouri), an estimated 71 million acres of non-agricultural land is available for potential conversion to monarch supportive habitat (Appendix 1). These lands include, the right-of-way along Interstate 35, transmission line easements, and lands classified as cropland-pasture, CRP, forage, grassland, and shrubland in each state.

Medium Term Actions:

- Continue to Evaluate Distribution and Abundance of Monarch Habitat. The spring and summer breeding ranges (Monarch/Milkweed Corridor) have been identified by Monarch Watch as high priority areas for reintroduction of forage habitat. The following states are included: Texas, Oklahoma, Arkansas, Kansas, Missouri, Iowa, Illinois, Indiana, Michigan, Wisconsin, Minnesota, and the eastern counties of Nebraska, North Dakota, and South Dakota. Of these states, the areas of the upper Midwest are the most important for activities of the CMRP to ensure adequate forage habitat for the generation that will overwinter in Mexico.

The distribution and abundance of known and potential monarch butterfly habitat will be evaluated. Potential habitat is defined as habitat that will meet certain biotic and abiotic conditions to support milkweed and adult nectar sources at any point in time. Known habitat is defined as those surveyed areas where milkweed and adult nectar sources have been found and which can support monarch butterflies. Known-occupied habitat is an area that currently supports monarch butterflies in association with milkweed and adult nectar sources.

The historical and current distribution and abundance of the monarch butterfly will be evaluated. States/counties with known occurrences for larvae and adults over specified time period will be correlated to known and potential habitat.

- Progressively Improve Geospatial Maps. Geographic Information System (GIS) technology can be used to develop a series of progressively more informed maps over a selected range of time. Probability models can be developed that identify monarch High Potential Range similar to those used for the Karner Blue Butterfly Recovery (<http://dnr.wi.gov/topic/ForestPlanning/karner/range.html>) to predict where habitat may occur or identify priority areas for habitat recovery.

Acreage used for recovery should be 1) capable of supporting the monarch butterfly now or in the future (i.e., within High Potential Range and on appropriate soils) and 2) chosen by the individual stakeholders for inclusion under the plan.

Mapping data will be made publically available to facilitate decision making on habitat restoration and encourage public participation in restoration activities.

- **Data Gaps and Research Needs:** While much is known about habitat improvement in general, research is still needed to understand how to implement habitat restoration programs on a larger scale. More research is needed within states to determine the best milkweed, forb and grass seed mixes for different types of land and geographies; and to develop methods to enable efficient, cost-effective and successful restoration, as well as methods and metrics for tracking progress and adapting programs based on population recovery.

Short Term Actions:

- Implement Research Programs in Key States. Iowa State University (ISU) has initiated a focused project to identify and understand data gaps that need to be better understood before moving from demonstration to large scale habitat improvement. ISU is designing a collaborative program, building upon the existing STRIPS project (Science-based Trials of Rowcrops Integrated with Prairie Strips; <http://www.nrem.iastate.edu/research/STRIPs/>).

The program will combine the efforts of scientists, educators, farmers, and extension specialists to examine the success, best practices, and feasibility of using prairie strips as an agricultural conservation practice and monarch/pollinator habitat. This program has the potential to be used as a model program for larger scale implementation in other states and across geographies.

Medium Term Actions:

- Determine Best Seed Mixtures and Supply by State and Land Area. Direct land management efforts represent a significant portion of the monarch butterfly habitat recovery efforts. These efforts will be focused on enhancing existing habitat, as well as the creation of new habitat. Data gaps exist on the tailoring of these recovery efforts to the specific ecology of monarchs and creating/maintaining monarch habitat. Further, limitations to monarch recovery may come in the form of seed limitation verses land limitations. Research and capacity building programs are needed to ensure 1) the right seed mixture per geographic area; and 2) and adequate supply of these seeds for large acreage recovery projects.
- Identify Short-term and Long-term Impacts of Management Activities. As academia will be an important partner in the CMRP, an active research program will be initiated and funded which covers topics related to the biology, restoration, recovery, monitoring and improvement of monarch butterflies, and their habitats.

Acquiring new knowledge through research can be a part of or inform an active adaptive management process, and result in improvements in CMRP implementation efficiencies and effectiveness, and improvements in management guidelines and conservation measures. Research results should be routinely shared with all CMRP partners.

Robust habitat to support adult and larval monarch depends upon a mixture of plant species and periodic disturbance. Therefore, these habitats will need to be managed and maintained to support monarch populations in the future. As part of the CMRP,

information is needed to identify short-term and long term impacts from management activities that will result in changes or enhancements to monarch butterfly habitat.

Insect conservation efforts are based on different premises than traditional vertebrate conservation efforts. The monarch butterfly, like most insect species, has adapted to survive by producing relatively large numbers of eggs and large populations, with short life spans of individual animals and frequent generation turnovers. For certain generations, most of the monarch butterfly's life is spent in the egg and larval stages. Natural mortality rates during these immature life stages are much greater than mortality rates observed for vertebrate animals. The survival strategy of the monarch butterfly relies on the success of overall populations/generations rather than individual animals. To accommodate this strategy, a focus on habitat conservation and the success of populations – rather than individuals – is critical for butterfly preservation. Accordingly, an emphasis of the CMRP research program moves away from the traditional measuring of individual specimens and toward managing for conservation of habitat and large populations.

- **Habitat Restoration and Adaptive Management:** Current programs for improving habitat for pollinators, monarch butterfly, or other wildlife should continue unabated. Habitat restoration initiatives by non-profit organizations and coalitions have been underway for many years and must continue to be supported in parallel to the CRMP.

Short Term Actions:

- Harmonize State Government Seeding Specifications to Include Milkweeds. Existing habitat improvement efforts supported by government agencies funding must allow planting of milkweeds in seeding specification lists for USDA and other public lands conservation programs (e.g., CRP lands). After incentives to plant habitat include milkweeds, these programs can be increased in scale with appropriate funding.

Medium Term Actions:

- Monitor Results and Adapt Practices. Adaptive management can be defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an on-going feedback loop for continuous improvement.

The adaptive management strategy will focus on achieving two primary CMRP monitoring goals: 1) to assess the effects of management activities on the monarch butterfly and its habitat and adjust conservation measures to better conserve the monarch where data and research support the change; 2) to assess new biological, economic and policy information and adjust operational parameters, programmatic and administrative procedures.

Integrating the monitoring program into the adaptive management strategy is crucial in order to guide any necessary changes in management.

- Develop Best Management Practices, Habitat Restoration Protocols, and Critical End Points. Restorations to benefit monarchs include the creation of quality milkweed and prairie habitat. These habitats may also support a broad range of associated grassland/prairie species including (but not limited to) other pollinators, song birds and

game birds. These habitats will vary slightly based upon geographic area and flexibility in plans in needed to accommodate landscapes across multi-state regions.

However, core elements of management plans and protocols should be transportable across geographies and will allow for consistency in implementation and evaluation of success.

As part of the CMRP, Best Management Practices (BMPs) and Habitat Restoration Protocols (HRPs) will need to be developed to aid in the establishment and monitoring of such habitats. Appropriate and measurable endpoints will be included in the BMPS and HRPs to facilitate evaluations of the success and impacts of the CMRP. The objective here will be to assess whether or not and to what degree CMRP management activities provide benefits to monarch habitat and ultimately to monarchs.

The resulting BMPs and HRPs will be based upon the best scientific and applied knowledge available. These BMPs and HRPs should be iterative and able to be refined based on accrued knowledge from several years experience after initiation of the CMRP.

- **International Collaboration and Information Exchange:** As the monarch butterfly's annual migration crosses international borders and includes Mexico and Canada, it is imperative that a US-based CMRP is transparent and supports trilateral activities that promote environmental cooperation and support. Monarch conservation will require trilateral action involving individuals, organizations and institutions.

Short Term Actions:

- Communicate CRMP Efforts to the Trilateral Committee. The Canada/Mexico/U.S. Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Trilateral Committee) has made a continuing commitment to support the conservation of monarch butterflies. The Trilateral Committee is headed by the directors of the Canadian Wildlife Service (CWS), the U.S. Fish and Wildlife Service (USFWS), and the Ministry of Environment and Natural Resources of Mexico (SEMARNAT).

As outlined in the 2008 North American Monarch Conservation Plan (http://www.mlmp.org/Resources/pdf/5431_Monarch_en.pdf) developed through the Commission for Environmental Cooperation (CEC), the following activities for overwintering monarchs in Mexico were recommended.

- Decrease or eliminate deforestation due to logging and habitat conversion
- Sustain benefits from tourism without harming monarch populations or habitat
- Determine causes of decreasing water availability and mitigate impacts on monarchs
- Determine impacts of plant and insect parasites on forests in monarch overwintering areas

Across the breeding areas for monarchs that exist between the US and Canada, the CEC plan made the following recommendations:

- Address the threats of habitat loss and degradation in the flyway
- Address the threats of the loss, fragmentation, and modification of breeding habitat

- Limit impact of habitat management practices on monarchs, flowering plants and milkweed

And across the entire annual range, the following recommendations were made:

- Investigate the effects of global climate change on monarch survival
- Assess the impacts of parasites and pathogens on monarchs and their host plants

Medium Term Actions:

- Ensure Open Dialogue and Open Access to Information. Other components of the CEC plan recommended actions in areas such as innovative enabling approaches; research, monitoring, evaluation and reporting; and education, outreach and capacity building. Reversing the trend of population decline in monarchs cannot be accomplished by policies and actions in one country alone. A concerted effort is needed that involves politicians, managers, scientists and the public to protect and restore habitat along its migratory route in the three countries, to ensure success. As efforts to facilitate monarch recovery are undertaken in the US it is imperative that the CMRP plans, data and research are open-access and readily made available across international efforts.

Appendix 1: Existing non-agricultural potential monarch habitat recovery areas within a six state region. (Preliminary data provided by University of Illinois at Chicago).

State	I-35 Distance* miles	Monarch Highway Buffer (I-35) [†] acres	Cropland-Pasture, CRP, Forage [‡] acres	Herbaceous Grassland [‡] acres	Shrubland [‡] acres	State Area ^Δ sq km	Line Length Ratio [◇] km/sq km	Total Line Length km	Transmission Line Easements [§] acres	Total Non-Agricultural Land acres
Minnesota	302	7,321	7,372,127	873,034	209,852	206,232	0.155	31,863	119,998	8,582,332
Wisconsin	N/A	N/A	7,040,976	444,648	168,010	140,268	0.135	18,936	71,315	7,724,948.98
Iowa	219	5,309	5,879,820	1,188,248	5,056	144,669	0.155	22,351	84,177	7,162,610
Kansas	234	5,673	27,720,886	0	164,778	211,754	0.135	28,587	107,660	27,998,997
Michigan	N/A	N/A	3,669,850	1,346,459	130,674	146,435	0.101	14,790	55,700	5,202,682.93
Missouri	115	2,788	14,599,983	87,620	14,483	178,040	0.135	24,035	90,519	14,795,393
TOTAL										71,466,963

* Distances sourced from: http://en.wikipedia.org/wiki/Interstate_35

[†] Assuming 100 ft buffer on each side

[‡] Data sourced from: Argonne National Laboratory GREET CCLUB Model available at <https://greet.es.anl.gov/publication-cclub-manual>

^Δ Land area sourced from: http://en.wikipedia.org/wiki/List_of_U.S._states_and_territories_by_area

[◇] Estimated from HSIP data provided by USGS Powell Center

[§] Assuming 100 ft easement and 50% conservativeness factor